Contents

Overview of TFAWS 2015

On behalf of the NASA Goddard Space Flight Center, welcome to the Washington DC area! The 26th Annual Thermal and Fluids Analysis Workshop (TFAWS), sponsored by the NASA Engineering and Safety Center (NESC) and hosted by the Goddard Space Flight Center (GSFC), is being held at the Silver Spring Doubletree Hotel from August 3rd-7th, 2015.

TFAWS was designed to encourage knowledge sharing, professional development, and networking throughout the thermal and fluids engineering discipline within NASA and beyond. The vision of TFAWS is to maintain continuity over time and between disciplines throughout the thermal and fluids engineering community. The three technical areas of focus are Passive Thermal Control, Life Support/Active Thermal, and Aerothermal.

The notable benefits of attending TFAWS include the following:

- Participants have the opportunity to share their work on the latest application of new and established methods to aerospace missions, impart engineering lessons learned, and compare/contrast engineering practices.
- Annual sharing of knowledge, hands-on instruction in relevant state-of-the-art engineering analysis tools, and seminars/short courses taught by experts and veterans in the thermal and fluids engineering disciplines, helps to ensure that expertise of the community is maintained.
- Networking at TFAWS gives each attendee an extensive network of contacts, serving as an excellent source for advice and technical knowledge.
- TFAWS provides tremendous opportunities for enhancing collaboration between NASA centers, other government agencies, industry, academia, and the international thermal and fluids engineering community.

Bringing together such a large sampling of the thermal and fluids community helps to ensure that perspectives are broadened and working relationships are maintained and expanded. This sharing of expertise between NASA centers and those in other government agencies, industry, academia, and international partners helps fuel the qualities of communication, teamwork, and technical excellence that are integral to NASA's core values. The conference's emphasis on teamwork with fellow professionals is a strategic component of an environment promoting the importance of safety, quality of work, and mission success.

You can visit TFAWS on our website for more information: https://tfaws.nasa.gov/

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https://twitter.com/TFAWS

Agenda Summary: Monday, August 3

	Monday August 3rd					
Starting time	**Council**	**Discovery**	**Inspiration**	**Ambassador**	**Leadership**	**Pinnacle**
7:30						
8:00						
8:30						
9:00	Modeling Methods Presentation Session I	Active Thermal Presentation Session I	Form Factors and Grey Bodies (Rickman)	Intro to Thermal Desktop		
9:30						
10:00						
10:30						
11:00						
11:30						
12:00						Lunch O'Shaughnessy
12:30						
13:00	Aerothermal Presentation Session I	Active Thermal Presentation Session II		NX Therm Demo	Thermal Hardware Design (Steinfeld)	
13:30						
14:00						
14:30			Systems Engineering (Pellerano)	Intro to NX Thermal		
15:00	Aerothermal Presentation Session II	Passive Thermal Presentation Session I				
15:30						
16:00						
16:30						
Night						Welcome Event

Agenda Summary: Tuesday, August 4

	Tuesday August 4th					
Starting time	**Council**	**Discovery**	**Inspiration**	**Ambassador**	**Leadership**	**Pinnacle**
7:30						
8:00	Aerothermal Presentation Session III	Passive Thermal Presentation Session II	Battery Thermal Design (Walker)	Intro to RadCAD	Intro to FEMAP Thermal/Flow	
8:30						
9:00						
9:30						
10:00	Aerothermal Testing (Berger, Berry)	Passive Thermal Presentation Session III	Heat Pipes (Ku)			
10:30						
11:00					ESATAN Demo	
11:30						
12:00						Lunch Roberts
12:30						
13:00	Modeling Methods Presentation Session II	Passive Thermal Presentation Session IV	Loop Heat Pipes (Ku)	COMSOL Multiphysics		
13:30						
14:00						
14:30						
15:00						Student Poster Session
15:30						
16:00						
16:30						
Night						Baseball Game

Agenda Summary: Wednesday, August 5

	Wednesday August 5th					
Starting time	**Council**	**Discovery**	**Inspiration**	**Ambassador**	**Leadership**	**Pinnacle**
7:30						
8:00	Passive TDT	Heat Pipe Presentation Session I	Cryo Design (DiPirro)			
8:30				ESATAN Thermal Modeling Suite		
9:00					Intro to TD Direct	
9:30						
10:00		ISS Payload Thermal Design (Carrillo)	STOP Analysis (Irish)			
10:30						
11:00						
11:30						
12:00						Lunch Hunter
12:30						
13:00	Active TDT	Passive Thermal Presentation Session V	Entry, Descent, and Landing (Tang)	TARP	Intro to TSS	
13:30						
14:00						
14:30						
15:00		Selecting Thermal Designs (Mosier, Mastropietro)	DPLR Demo			
15:30						
16:00						
16:30						
Night						Keynote Thaller

Agenda Summary: Thursday, August 6

<table>
<tr><td></td><td colspan="6">Thursday August 6th</td></tr>
<tr><td>Starting time</td><td>Council</td><td>Discovery</td><td>Inspiration</td><td>Ambassador</td><td>Leadership</td><td>Pinnacle</td></tr>
<tr><td>7:30</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8:00</td><td rowspan="8">TESC Meeting</td><td rowspan="4">Passive Thermal Presentation Session VI</td><td rowspan="4">Common Modeling Mistakes (Amundsen)</td><td rowspan="4">COVER</td><td rowspan="8">Intro to GFSSP</td><td rowspan="8">GSFC Tour 10-11:30, overall 9:15-12

Meet in lobby</td></tr>
<tr><td>8:30</td></tr>
<tr><td>9:00</td></tr>
<tr><td>9:30</td></tr>
<tr><td>10:00</td><td rowspan="4">Heat Pipe Presentation Session II</td><td rowspan="4">Science Goals to Reqts (Reuter)</td><td></td></tr>
<tr><td>10:30</td><td></td></tr>
<tr><td>11:00</td><td></td></tr>
<tr><td>11:30</td><td></td></tr>
<tr><td>12:00</td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">Lunch Rickman</td></tr>
<tr><td>12:30</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>13:00</td><td rowspan="3">Heat Pipe Presentation Session III</td><td rowspan="3">Contam for Thermal (Rivera)</td><td rowspan="3">New Features in CRTech</td><td rowspan="6">TFAWS Steering Meeting</td><td rowspan="6">CAD Transfer using TSS</td><td rowspan="6">GSFC Tour 1:30-3:30, overall 1-4:15

Meet in lobby</td></tr>
<tr><td>13:30</td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:30</td><td rowspan="4">Interdisciplinary Presentation Session</td><td rowspan="4">Coatings for Thermal (Triolo)</td><td rowspan="4">PM for Thermal Leads (Simmons)</td></tr>
<tr><td>15:00</td></tr>
<tr><td>15:30</td></tr>
<tr><td>16:00</td></tr>
<tr><td>16:30</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Night</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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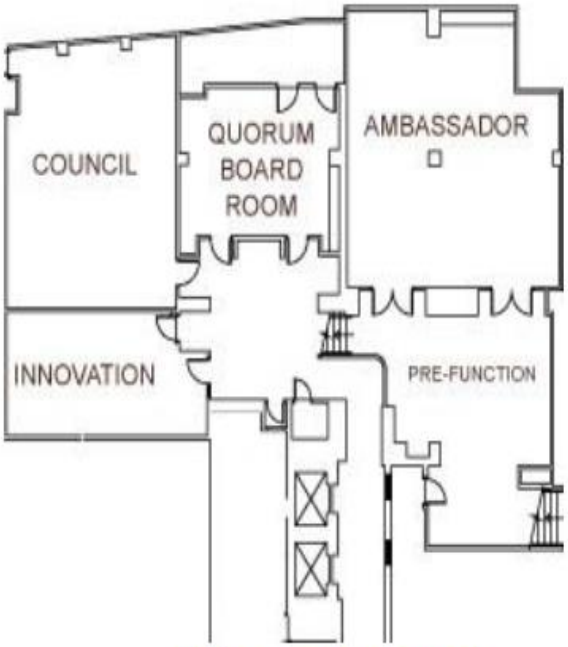
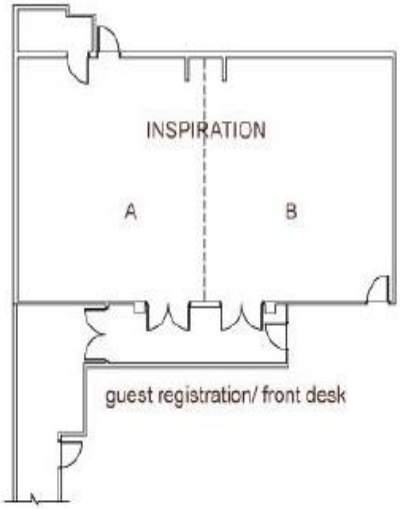
Agenda Summary: Friday, August 7

	Friday August 7th					
Starting time	**Council**	**Discovery**	**Inspiration**	**Ambassador**	**Leadership**	**Pinnacle**
7:30						
8:00				Advanced TSS		
8:30						
9:00		SmallSat / CubeSat (Rodriguez & Patel)			Flownex Tutorial	
9:30						
10:00						
10:30						
11:00						
11:30						

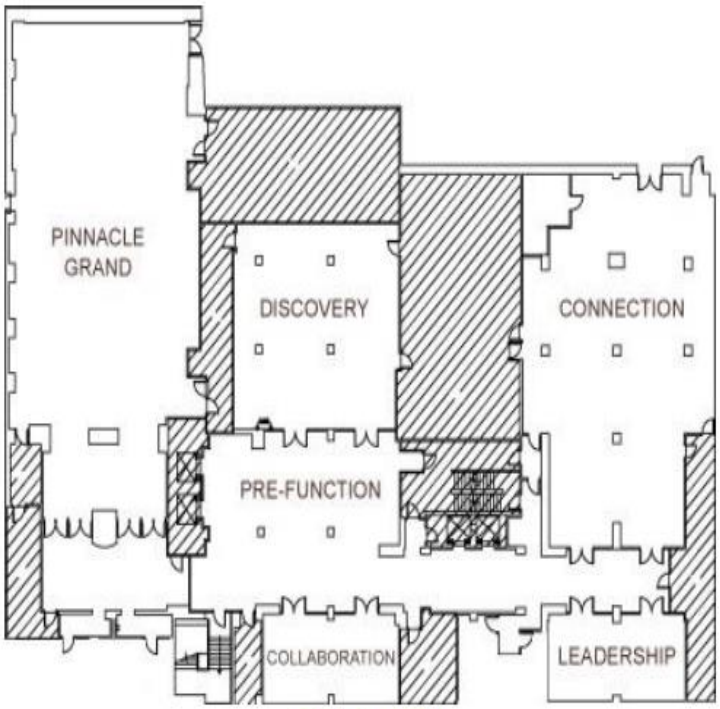
Map of Meeting Space At The Silver Spring Doubletree Hotel



Mezzanine Level



Lobby Level



2nd Level

Session Descriptions: Monday, August 3

Modeling Methods Presentation Session I
9:00am – 12:00pm
Council Room
Session Chairs: Ruth Amundsen (NASA LaRC), Tim Risch (NASA AFRC)

9:00	TFAWS15-MM-01	"High-Order Numerical Simulation of Shock/Boundary Layer Interaction over Surface Roughness Using the FR/CPR-DG Method" *Presenter: Meilin Yu (University of Maryland, Baltimore County)*
9:30	TFAWS15-MM-02	"Analytical Methodology Used to Assess/Refine Proposed Observatory Thermal Vacuum Test Conditions for the LandSat 8 Data Continuity Mission" *Presenter: Louis Fantano (NASA GSFC)*
10:00	TFAWS15-MM-03	"Environmental Simulation of a Spacecraft on a Launchpad" *Presenter: Ron Behee (MSC Software)*
10:30	TFAWS15-MM-04	"Investigation on the Practicality of Developing Reduced Thermal Models" *Presenter: Giancarlo Lombardi (Florida International University)*
11:00	TFAWS15-MM-05	"Assessment of OpenFOAM CFD library for numerical simulations of shock turbulence interactions" *Presenter: Salman Verma (University of Maryland)*
11:30	TFAWS15-MM-06	"Thermal Modeling Method Improvements for SAGE III on ISS" *Presenter: Kaitlin Liles (NASA LaRC)*

Active Thermal Presentation Session I
9:00am – 12:00pm
Discovery Room
Session Chairs: Monica Guzik (NASA GRC), Craig Dinsmore (NASA JSC)

9:00	TFAWS15-AT-01	"Thermal Design of Vapor cooling of Flight Vehicle Structures using Cryogenic Propellant Boil-off" *Presenter: Xiao-Yen Wang (NASA GRC)*

9:30	TFAWS15-AT-02	"Numerical simulations of supersonic film cooling for liquid rocket nozzle applications: A validation study" *Presenter: Salman Verma (University of Maryland)*
10:00	TFAWS15-AT-03	"New Data for Improvement of a Monte Carlo Model of Spray Cooling" *Presenter: John Kuhlman (West Virginia University)*
10:30	TFAWS15-AT-04	"Thermal Fluid Analysis for Nuclear Thermal Propulsion Radiation Shield" *Presenter: Carlos Gomez (NASA MSFC)*
11:00	TFAWS15-AT-05	"Embedded Thermal Control Subsystems for Small Spacecraft" *Presenter: Jeff Didion (NASA GSFC)*
11:30	TFAWS15-AT-06	"Utilization of Variable Emissivity Electrochromic Devices for Space Suit Thermal Control" *Presenter: Chris Massina (University of Colorado, Boulder)*

Form Factors, Grey Bodies and Radiation Conductances
9:00am – 12:00pm
Ambassador Room
Instructor: Steven Rickman, JSC

Students are introduced to basic thermal radiation analysis in undergraduate heat transfer courses but little focus in given to techniques employed for thermal radiation analysis in the real world. This theory-based short course provides an introduction to thermal radiation form factors, grey bodies and radiation conductances. Various techniques of form factor calculation are explored and demonstrated. Radiation interchange using both Monte Carlo and radiosity techniques is demonstrated.

Introduction to C&R Thermal Desktop® and FloCAD®
9:00am – 12:00pm
Ambassador Room
Instructor: Douglas Bell (Cullimore and Ring)

This session will provide an introduction to the capabilities of Thermal Desktop and FloCAD through the creation of simple models that include radiation and fluid flow. Thermal Desktop is a pre- and postprocessor for SINDA; FloCAD adds fluid model development based on thermal model geometry and flow path centerlines. No previous experience with Thermal Desktop is expected. Experienced users are welcome but are requested to allow new users to have priority at the workstations.

Lunch: Extreme Spacecraft Engineering
12:00pm – 1:00pm
Pinnacle Ballroom
Speaker: Dan O'Shaughnessy (JHU APL)

The Johns Hopkins University Applied Physics Laboratory Space Exploration Sector has the privilege of conducting investigations of some of the most extreme places in the solar system for NASA. From exploring the Pluto system, 4.5 light-hours from Earth, to flying into the outer corona of the sun itself, or living in the Van Allen radiation belts around the Earth, APL spacecraft are (or will be) contributing to discoveries from one end of our solar system to the other. The challenges of delivering the science from these extreme environments at reasonable cost requires disciplined, innovate engineering. How these challenges are being met on the New Horizons, MESSENGER, Solar Probe Plus, and Van Allen Probes spacecraft will be discussed.
Bio: Mr. Dan O'Shaughnessy graduated from the University of Missouri with BS and MS degrees in mechanical and aerospace engineering. After graduation, he joined the Johns Hopkins University Applied Physics Laboratory (APL) as a guidance and control engineer. He has been involved with MESSENGER since joining APL in 2000, previously leading the guidance and control team through cruise, Mercury orbit insertion, and the first year of orbit operations. Dan has also supported NEAR (Near Earth Asteroid Rendezvous), STEREO (Solar TErrestrial RElations Observatory), and New Horizons, in addition to working numerous research and flight projects in control systems, algorithm and software development, and autonomous on-orbit commissioning and calibration. He is currently MESSENGER's Mission Systems Engineer, making him responsible for all technical aspects of the program. In 2014, Dan was awarded the inaugural Heinlein Award for Space Technology for his work supporting MESSENGER's flight demonstration of solar sailing.

Aerothermal Presentation Session I
1:00pm – 3:00pm
Council Room
Session Chairs: Karen Berger (NASA LaRC), Jason Mishtawy (NASA MSFC)

1:00	TFAWS15-AE-01*	"CFD Analysis of the Multi-Purpose Crew Vehicle (Orion) Crew Module Adaptor / Service Module / Delta Cryogenic Upper Stage (DCUS) Vent and Purge Process" *Presenter: Tony Iannetti (NASA GRC)*
1:30	TFAWS15-AE-02	"Heat Flux Measurements for Supersonic Film Cooling" *Presenter: Colin Adamson (University of Maryland)*
2:00	TFAWS15-AE-03	"Heat-Transfer Measurement Capabilities in the NASA Ames Hypervelocity Free Flight Aerodynamic Facility"

Presenter: Mike Wilder (NASA ARC)

2:30 TFAWS15-AE-04 "Performance Characterization of a Small Turbojet Engine Platform for an Engine-Integrated Solid Oxide Fuel Cell System"
Presenter: Stephen Vannoy (University of Maryland)

* Marked papers are only open to US Citizens that have been pre-screened by NASA GSFC security

Active Thermal Presentation Session II
1:00pm – 3:00pm
Discovery Room
Session Chairs: Monica Guzik (NASA GRC), Craig Dinsmore (NASA JSC)

1:00 TFAWS15-AT-07 "Erosion-Corrosion, Clogging, and Fracture in Microchannel Coolers for Thermally Integrated Power Electronics"
Presenter: David Squiller (University of Maryland)

1:30 TFAWS15-AT-08 "The January 2015 Repressurization of ISS ATCS Loop B – Analysis Limitations and Concerns"
Presenter: Eugene Ungar (NASA JSC)

2:00 TFAWS15-AT-09 "Gravity Effects in Microgap Flow Boiling"
Presenter: Frank Robinson (NASA GSFC)

2:30 TFAWS15-AT-10 "ISS-CREAM Thermal and Fluid System Design, Analysis, and Testing"
Presenter: Rosemary Thorpe (Bastion Technologies)

Demonstration of NX Advanced Simulation and the NX Thermal/Flow Solutions
1:00pm – 2:30pm
Ambassador Room
Instructor: Carl Poplawsky (Maya Heat Transfer Technologies)

NX Advanced Simulation is part of the Siemens PLM Software NX CAD/CAE environment, providing support for multiple solvers including NX Thermal, Flow, Electronic Systems Cooling, and Space Systems Thermal. This demonstration will provide a broad overview of the software simulation features, with a focus on unique capabilities supporting CAD-centric analysis work flows that enhance the analysis-driven design experience. NX CAE (Advanced Simulation) supports NX CAD native and multi-CAD geometry with full parametric capabilities, furnishing CAE pre/post-processing for a wide range of NX and 3rd party solvers, all within a single unambiguous user interface. Key features to watch for in this software demonstration include:

Use of 3rd party CAD data with full associativity; automated geometry abstraction (simplification) for meshing; unique assembly-level finite element modeling capability to leverage the CAD assembly with associativity; automated tools for defining thermal connectivity's between assembly components; coupled Thermal/Flow analysis; robust temperature mapping capability to structural solvers, including NX Nastran; and thermal deflection study resulting from Thermal/Flow analysis.

Thermal Hardware for Thermal Analysts
1:00pm – 3:00pm
Leadership Room
Instructor: David Steinfeld (NASA GSFC)

Most Thermal analysts do not have a good background into the hardware which thermally controls the spacecraft they design. SINDA and Thermal Desktop models are important, but knowing how this applies to the actual thermal hardware (heaters, thermostats, thermistors, MLI blanketing, optical coatings, etc...) is just as critical. The course will delve into the thermal hardware and their application techniques on actual spacecraft. Knowledge of how thermal hardware is used and applied will make a thermal analyst a better engineer.

Introduction to NX Thermal, Flow, Electronic Systems Cooling, and Space Systems Thermal
2:30pm – 5:00pm
Ambassador Room
Instructor: Carl Poplawsky (Maya Heat Transfer Technologies)

NX Thermal, Flow, Electronic Systems Cooling (ESC), and Space Systems Thermal (SST) are part of the Siemens PLM Software NX CAE environment, providing comprehensive capability for thermal/fluids analysis. This activity will provide a broad overview of the software simulation features, with a focus on unique capabilities supporting CAD-centric analysis work flows that enhance the analysis-driven design experience. NX CAE supports NX CAD native and multi-CAD geometry with full parametric capabilities, furnishing CAE pre/post-processing for a wide range of NX and 3rd party solvers, all within a single unambiguous user interface. NX Thermal simulates conduction, convection and radiation phenomena for complex products and large assemblies. NX Flow is a computational fluid dynamics (CFD) solution providing sophisticated tools to model and simulate fluid flow; both solvers can run in coupled fashion for true multi-physics. NX ESC leverages the NX Flow and Thermal solvers as well as NX PCB Exchange (for bi-directional access to ECAD data) in an integrated multi-physics environment to simulate 3D air flow and thermo-fluid behavior in electronic systems. NX SST provides a comprehensive set of tools for spacecraft thermal analysis, leveraging the capabilities of NX Thermal plus specific tools for trajectory and orbital calculations.

Systems Engineering

2:30pm – 5:00pm
Inspiration Room
Instructor: Fernando Pellerano (NASA GSFC)

This short course provides information on what systems engineering is and how the systems engineer guides requirements, interfaces with the discipline leads, and resolves technical issues. There are many system-wide issues that either impact or are impacted by the thermal subsystem. This course will introduce these issues and illustrate them with real life examples.

Aerothermal Presentation Session II
3:00pm – 5:00pm
Council Room
Session Chairs: Karen Berger (NASA LaRC), Jason Mishtawy (NASA MSFC)

3:00	TFAWS15-AE-05	"Focused Schlieren Imaging for Supersonic Film Cooling" *Presenter: Chandan Kittur (University of Maryland)*
3:30	TFAWS15-AE-06	Withdrawn
4:00	TFAWS15-AE-07	"Computational and Experimental Investigation of Water Droplet Freezing on Micro Scale Pillars Placed on Cold Substrates" *Presenter: Iman Mirzaee (University of Massachusetts Lowell)*
4:30	TFAWS15-AE-08	"Computational Investigation of Ignition Delay for Various Fuels in a Heated Cavity-Stabilized Combustor" *Presenter: Cameron Butler (University of Maryland)*

Passive Thermal Presentation Session I
3:00pm – 5:00pm
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

3:00	TFAWS15-PT-01	"Thermal Isolation and Differential Cooling of Heterogeneously Integrated Devices" *Presenter: Mike Fish (University of Maryland)*
3:30	TFAWS15-PT-02	"Thermally Conductive Silicones for Space Applications" *Presenter: Vincent Malavé (NuSil Technology)*
4:00	TFAWS15-PT-03	Withdrawn

4:30 TFAWS15-PT-04 Withdrawn

Welcome Reception
6:00pm
Hotel Lobby
Meet in the lobby to head over to Denizen's Brewing Company for an evening of local microbrews, BBQ, and lawn games. It is an 0.8 mile walk, and the hotel shuttle is available as well.

Session Descriptions: Tuesday, August 4

Aerothermal Presentation Session III
8:00am – 10:00am
Council Room
Session Chairs: Karen Berger (NASA LaRC), Jason Mishtawy (NASA MSFC)

8:00	TFAWS15-AE-09	"Enhancement of an Emergency Shelter for Forest Firefighters by Improving Resistance to Convective Heating" *Presenter: Josh Fody (NASA LaRC)*
8:30	TFAWS15-AE-10	"Surface heat-flux measurements in hypersonic flows using fast-response temperature sensitive paint" *Presenter: Stuart Laurence (University of Maryland)*
9:00	TFAWS15-AE-11	"An Upgrade of the Imaging for Hypersonic Experimental Aeroheating Testing (IHEAT) Software" *Presenter: Michelle Mason (NASA LaRC)*
9:30	TFAWS15-AE-12	"Infrared Images of Boundary Layer Transition on the D8 Transport Configuration in the LaRC 14- by 22-Foot Subsonic Tunnel" *Presenter: Michelle Mason (NASA LaRC)*

Passive Thermal Presentation Session II
8:00am – 10:00am
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

8:00	TFAWS15-PT-05	"Thermal Control Design, Analysis, and Test for the Radiation Dosimetry Experiment (RaD-X)" *Presenter: Rebecca Stavely (NASA LaRC)*
8:30	TFAWS15-PT-06	"Dewar Configuration as an Approach to Maximizing the Cooling of Heat Loads in Two-Temperature Dewars" *Presenter: Narcrisha Norman (Howard University)*
9:00	TFAWS15-PT-07	"SAGE III on ISS Lessons Learned on Thermal Interface Design" *Presenter: Warren Davis (NASA LaRC)*
9:30	TFAWS15-PT-08	"Continued Water-Based Phase Change Material Heat

Exchanger Development"
Presenter: Scott Hansen (NASA JSC)

Lithium-ion Batteries: Fundamentals, Thermal Performance, and Understanding Thermal Runaway/Propagation
8:00am – 10:00am
Inspiration Room
Instructor: William Walker (NASA JSC)

This short course provides discussion on three aspects to lithium-ion (Li-ion) batteries that are relevant to the TFAWS community. First an understanding of Li-ion battery fundamentals is provided through discussion centered around the aerospace industry's choice to use Li-ion batteries, general performance characteristics, and electrochemical reaction basics. Secondly, thermal performance during nominal charge-discharge operations is discussed building from a general energy balance for representing the local heat generation of a given Li-ion cell. Finally a discussion on understanding the causes and effects of thermal runaway and propagation is presented. The overall goal of the course is to provide participants with an in-depth understanding of the thermal aspects to lithium-ion battery test and analysis.

Introduction to RadCAD®
8:00am – 11:00am
Ambassador Room
Instructor: Douglas Bell (Cullimore and Ring)

This session will provide an introduction to the capabilities of RadCAD through the creation of simple radiation models. RadCAD performs surface-to-surface radiation exchange calculations and environmental heating calculations. No previous experience with Thermal Desktop is expected. Experienced users are welcome but are requested to allow new users to have priority at the workstations.

Introduction to Femap Thermal and Flow
8:00am – 10:00am
Leadership Room
Instructor: Carl Poplawsky (Maya Heat Transfer Technologies)

Femap Thermal and Flow are part of the Siemens PLM Software Femap environment, providing comprehensive capability for thermal/fluids analysis. This activity will provide a broad overview of the software simulation features. Femap is a sophisticated stand-alone CAE pre/post-processor for importing multi-CAD geometry and supporting a wide range of NX and 3rd party CAE solvers. Femap Thermal simulates conduction, convection and radiation phenomena for complex products and large assemblies, with a comprehensive set of tools for spacecraft trajectory and orbital thermal analysis. Femap Flow is a computational fluid dynamics (CFD)

solution providing sophisticated tools to model and simulate fluid flow; both solvers can run in coupled fashion for true multi-physics.

Aerothermal Ground Testing: How, Where and Why?
10:00am – 12:00pm
Council Room
Instructor: Scott Berry (NASA LaRC) and Karen Berger (NASA LaRC)

This course will include an overview of the major hypersonic ground test facilities around the country and their capabilities. Test techniques and instrumentation available to researchers will be covered as well. A summary of a number of major ground testing and flight programs over the years will be covered and will highlight the significant contributions obtained through ground testing. This will include blunt, slender and winged configurations.

Passive Thermal Presentation Session III
10:00am – 12:00pm
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

10:00	TFAWS15-PT-09	"Lessons learned during the refurbishment and testing of an observatory after long-term storage" *Presenter: John Hawk (NASA GSFC)*
10:30	TFAWS15-PT-10	"Thermal Control Architecture Trade Study for the Europa Clipper Pre-Project Study" *Presenter: Hared Ochoa (JPL)*
11:00	TFAWS15-PT-11	Withdrawn
11:30	TFAWS15-PT-12	"Correlation of the SAGE III on ISS Sensor Assembly Thermal Model to Thermal Vacuum Testing" *Presenter: Ruth Amundsen (NASA LaRC)*

Introduction to Heat Pipes
10:00am – 12:00pm
Inspiration Room
Instructor: Jentung Ku (NASA GSFC)

This course will present operating principles of the heat pipe with emphases on the underlying physical processes and requirements of pressure and energy balance. Performance characterizations and design considerations of the heat pipe will be highlighted. Guidelines for thermal engineers in the selection of heat pipes as part of the spacecraft thermal control system, testing methodology, and analytical modeling will also be discussed.

ESATAN-TMS Demonstration
11:00am – 12:00pm
Leadership Room
Instructor: Nicolas Bures (ITP)

ESATAN-TMS provides a complete environment to support the full thermal analysis process, including geometry modelling, radiative analysis, thermal-hydraulic analysis and post-processing of results. The high-productivity user interface supports a wide range of features which allow fast and accurate simulation, however complex the problem. ESATAN-TMS provides the ability to create thermal models comprising of 2D (shells) and/or 3D (solids) geometry, automatically identifying interfaces between the geometric primitives. The user can choose to perform the thermal analysis using either a lumped parameter or a finite element approach; or even a combination of both techniques within the same model, as best suited to the problem being solved.
The session shall start by providing an overview of the product's thermal modelling capabilities, followed by a live demonstration. The demonstration will show how easy a model can be created in ESATAN-TMS, with the option to import components of the model directly from CAD. A full radiative and thermal analysis will be performed, highlighting the major features of the product, concluding by post-processing of the thermal results. Further experience of ESATAN-TMS can be gained by attending the hands-on TFAWS session scheduled for the 5 August 2015

Lunch: Challenges of On-Orbit Satellite Servicing
12:00pm – 1:00pm
Pinnacle Ballroom
Speaker: Brian Roberts (NASA GSFC)

This presentation will review the challenges in simulating on-orbit robotic satellite servicing on the ground at NASA Goddard Space Flight Center. These challenges range from using industrial robots to simulate space robot dynamics to testing refueling operations that are impacted greatly by microgravity. NASA's ongoing Robotic Refueling Mission (RRM) launched on the last space shuttle will be highlighted along with the specialized robotic tools built for the mission. Mission support such as communications, video, and operator interfaces will also be discussed.

Modeling Methods Presentation Session II
1:00pm – 3:00pm
Council Room
Session Chairs: Ruth Amundsen (NASA LaRC), Tim Risch (NASA AFRC)

1:00	TFAWS15-MM-07	"A Comparison of Geometric Discretization Methods" *Presenter: Douglas Bell (Cullimore and Ring)*

1:30 TFAWS15-MM-08 "Bayesian-based Simulation Model Validation for Spacecraft Thermal Systems"
Presenter: Conor McMenamin (Massachusetts Institute of Technology)

Passive Thermal Presentation Session IV
1:00pm – 3:00pm
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

1:00 TFAWS15-PT-13 "SWOT Loop Heat Pipe Evaporator Joint Conductance Testing"
Presenter: Ben Marshall (JPL)

1:30 TFAWS15-PT-14 "Thermal Considerations for High Power and Interplanetary CubeSats"
Presenter: Daniel Forgette (JPL)

2:00 TFAWS15-PT-15 "Evaluation Test of Quantum Dots in Heat Transfer Applications"
Presenter: Husain Al Hashimi (University of Maryland)

2:30 TFAWS15-PT-16 "Thermal Model Development for an X-ray Mirror Assembly"
Presenter: Joe Bonafede (SGT Inc.)

Introduction to Loop Heat Pipes
1:00pm – 3:00pm
Inspiration Room
Instructor: Jentung Ku (NASA GSFC)

This course will discuss operating principles and performance characteristics of a loop heat pipe. Topics include: 1) pressure profiles in the loop; 2) loop operating temperature; 3) operating temperature control; 4) loop startup; 4) loop shutdown; 5) loop transient behaviors; 6) sizing of loop components and determination of fluid inventory; 7) analytical modeling; 8) examples of flight applications; and 9) recent LHP developments.

Thermal and Fluid Flow Analysis with COMSOL
1:00pm – 3:00pm
Ambassador Room
Instructor: Miraj Desai (COMSOL Inc)

Discover the power of COMSOL Multiphysics for thermal and fluid flow analysis in this workshop. Learn to model transport phenomena such as conduction of heat through solids, convection by moving fluids and radiation of heat via infrared. Also, find out how to couple these analyses with one another and how they interact with other physics such as structural mechanics (thermal stresses), electromagnetics (EM heating) etc. The motto of this workshop is "learn-by-doing". There will be an opportunity to try COMSOL with the help of the instructor. The goal is to teach you the skills needed to model problems in COMSOL Multiphysics. Who should attend? Anyone interested in simulating and optimizing engineering phenomena based on PDEs, such as structural mechanics, heat transfer, electromagnetics, fluid flow, etc.

Student Poster Session
3:00pm – 4:30pm
Pinnacle Ballroom

Washington Nationals Baseball Game
5:45pm
Hotel Lobby
Meet in the lobby to take the Metro to the baseball game. Tickets must have been bought ahead of time.

Session Descriptions: Wednesday, August 5

NESC Passive Thermal Technical Discipline Team Meeting – Invite Only
8:00am – 12:00pm
Council Room

Heat Pipe Presentation Session I
8:00am – 10:00am
Discovery Room
Session Chairs: Jentung Ku (NASA GSFC) and Franklin Robinson (NASA GSFC)

8:00	TFAWS15-HP-01	"Alkali Metal Heat Pipes for Space Fission Power" *Presenter: Calin Tarau (Advanced Cooling Technologies)*
8:30	TFAWS15-HP-02	"Variable Heat Rejection Multiple LHP Radiator for Future Spacecraft" *Presenter: Nathan Van Velson (Advanced Cooling Technologies)*
9:00	TFAWS15-HP-03	"Hybrid Heat Pipes for Planetary Surface and High Heat Flux Applications" *Presenter: Mohammed Ababneh (Advanced Cooling Technologies)*
9:30	TFAWS15-HP-04	"High Temperature Water-Titanium Heat Pipe Radiators for Spacecraft Fission Power" *Presenter: Bill Anderson (Advanced Cooling Technologies)*

Cryo Design, Implementation, and Design/Testing
8:00am – 10:00am
Inspiration Room
Instructor: Mike DiPirro (NASA GSFC)

This short course provides some basic principles of cryogenics. The differences between room temperature and cryogenic thermal analysis, namely temperature dependent properties, will be discussed. Practical information, such as the materials for thermal contact and isolation, will be included. The verification process and instrumentation used that is unique to cryogenic (in general < 100K) systems will be described.

ESATAN-TMS Hands-on Training
8:30pm – 11:30am
Ambassador Room

Instructor: Nicolas Bures (ITP)

This hands-on training will allow the attendees to gain knowledge and valuable experience of ESATAN-TMS. The training will cover geometry simplification and modification of the CAD geometry through CADbench 2015 and then working with the model within ESATAN-TMS Workbench. Through ESATAN-TMS Workbench, the design of a satellite test model will be finalized, radiative analysis performed to calculate heat fluxes and radiative exchange factors. Both Steady state and transient thermal analysis will be performed, followed by post-processing of the results using the extensive capabilities provided within ESATAN-TMS. Design consideration will be given to material selection and other key parameters to achieve the desired thermal requirements.
This hands-on training will be an easy step-by-step workflow, with two ESATAN-TMS experts on hand to provide an effective training experience.

Introduction to CRTech TD Direct®
9:00am – 12:00pm
Leadership Room
Instructor: Douglas Bell (Cullimore and Ring)

This session will provide an introduction to the capabilities of CRTech TD Direct. TD Direct is powerful software that fills the gap between design geometry and C&R Thermal Desktop. TD Direct is an add-in to ANSYS SpaceClaim, a CAD tool that focuses on preparing geometry for analysis, just as Thermal Desktop is built in AutoCAD. With TD Direct, the user is able to solve many of the problems that have challenged thermal engineers for years. The starting point is the full design geometry in any format. The final product is the completed analysis in Thermal Desktop. The step in between is TD Direct, where the user has the ability to easily simplify, heal, and alter the geometry while working with an exceedingly capable mesher.

Thermal Design Considerations for Hardware on ISS
10:00am – 12:00pm
Discovery Room
Instructor: Laurie Carrillo, Dave Farner, and Caryn Preston (NASA JSC)

The purpose of this course is to help an external payload developer understand the potential thermal environments associated with the various mission phases from launch to installation on the International Space Station (ISS). In addition, the course will focus on thermal analysis resources/approaches which have been developed by the ISS Passive Thermal Control System (PTCS) team to support external payload development. An overview of the ISS-Program baseline thermal model and model integration tips will be provided.

Structural, Thermal and Optical Performance (STOP) Analysis
10:00am – 12:00pm
Inspiration Room

Instructor: Sandra Irish (NASA GSFC)

A STOP analysis is a multidiscipline analysis, consisting of Structural, Thermal and Optical Performance Analyses, that is performed for all space flight instruments and satellites. This course will explain the different parts of performing this analysis. The student will learn how to effectively interact with each discipline in order to accurately obtain the system analysis results.

Lunch: Managing NASA Missions with Federal Budget Uncertainty
12:00pm – 1:00pm
Pinnacle Ballroom
Speaker: Andrew Hunter (NASA HQ)

The federal budgeting process is complicated and somewhat frustrating given the system we work in. As a result of this complicated environment, stakeholders in the political system who influence the budget are pushed and pulled in many directions so the decisions they make can seem contradictory and hard to follow. Individuals can end up feeling there is no direct line from what they do to the outcomes they see (e.g., budget levels and program priorities). They can end up believing they have no "voice" in the system. In fact, individuals in our Agency, and our Agency leadership, do have a voice, and we can help ourselves work within the system. NASA works closely with Congress and the Executive Branch to determine our Agency priorities, define missions, and guarantee the funding to make them real.

NESC Active Thermal Technical Discipline Team Meeting – Invite Only
1:00pm – 3:00pm
Council Room

Passive Thermal Presentation Session V
1:00pm – 3:00pm
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

1:00	TFAWS15-PT-17	"Experimental and Numerical Study of Nanoemulsion Heat Transfer Fluid" *Presenter: Naresh Poudel (University of the District of Columbia)*
1:30	TFAWS15-PT-18	"Two-Phase Thermal Switch for Passive Thermal Management" *Presenter: Nathan Van Velson (Advanced Cooling Technologies)*
2:00	TFAWS15-PT-19	"Early Operations Flight Correlation of the Lunar Laser

		Communications Demonstration (LLCD) on the Lunar Atmosphere and Dust Environment Explorer (LADEE)" *Presenter: Kan Yang (NASA GSFC)*
2:30	TFAWS15-PT-20	"Critical Heat Flux Mechanisms During Pool Boiling of NOVEC-7000 on a Wicking Surface" *Presenter: Jason Thompson (University of Maryland)*

Aerothermal Design Considerations for Entry, Descent, and Landing
1:00pm – 3:00pm
Inspiration Room
Instructor: Chun Tang (NASA ARC)

This course provides an introduction to aerothermal design considerations for a spacecraft entering, descending, and landing in a planetary atmosphere. In particular, this course will describe the use of Computational Fluid Dynamics (CFD) tools for aerothermal simulations at hypersonic and supersonic conditions. The class will discuss some best practices for aerothermal modeling and highlight some challenges related to aerothermodynamic simulations and model validation.

TARP: Thermal Analysis Results Processor Training
1:00pm – 5:00pm
Ambassador Room
Instructor: Hume Peabody (TMS)

TARP is a Windows® based post-processing program that creates an interface between the output from numerous thermal analysis solvers and Microsoft Excel®. Users define the post-processing objects within the TARP environment to create in the output Excel workbook, including: DataSets, Plots, Tables, Strip Charts, etc. A user also has the ability to define further data points such as group averages, maximums and minimums and define objects to use these values instead of raw nodal results. More advanced objects are also available including Graphical Tables, Equivalent Sinks and Backloads, and Radk Comparisons. Lastly, features exist for the creation of a specialized workbook for the evaluation of nodal heatflows, which can further be extended to heatflows between the defined groups. The full power and capability or Microsoft Excel is then available to the end user with all requested data in the output workbook for further processing if needed.

Introduction to TSS
1:00pm – 5:00pm
Leadership Room
Instructor: Joe Lepore, Joe Clay (SpaceDesign)

This hands-on class will progress through a thermal analysis of a spacecraft. The student will go through each major step in the analysis process using a simple example. This is the basic framework needed to create, analyze, and obtain temperatures using TSS. The spacecraft model will begin as a CAD file, which is moved into TSS by using the Transfer application. As each TSS application is used, user interface and TSS features are demonstrated by the instructor and utilized by the student. Calculations of radks, heating rates, conduction/capacitance network, and temperatures are performed. The latest TSS capabilities demonstrated in this class include the return of the Executive application for Windows and SindaWin application. Everyone interested in learning how to perform satellite thermal analysis should attend this class.

Thermal Design Parameters and Case Studies (COBE and LDSD)
3:00pm – 5:00pm
Discovery Room
Instructor: Carol Mosier (NASA GSFC) and A.J. Mastropietro

This short course will present a brief introduction into the parameters that effect thermal design. Two case studies showing how the thermal design evolves from the mission specific requirements will be given. The first case study is for the Cosmic Background Explorer (COBE) spacecraft and instruments. The COBE mission, which proved the big bang theory, utilized cryogenic instruments that needed to be colder than space to collect the required science data. The resulting design and thermal challenges will be highlighted. The second case study is for the Low Density Supersonic Decelerator (LDSD) Supersonic Flight Dynamics Test (SFDT) vehicle. The vehicle's thermal control system had to protect avionics, batteries, cameras, data recorders, and the composite core structure during the freezing cold balloon assisted ascent as well as during the solid rocket powered flight which posed a high heating environment. An introduction to NASA's LDSD technology demonstration program and a brief review of the thermal design and analysis of the test vehicle including bounding environments will be presented along with some of the thermal telemetry from the first flight followed by several hard lessons learned.

Introduction to the Data-Parallel Line Relaxation (DPLR) Software Package
3:00pm – 5:00pm
Inspiration Room
Instructor: Chun Tang (NASA ARC)

This training course will provide an introduction to the DPLR software package, a suite of Computational Fluid Dynamics (CFD) tools developed at NASA Ames Research Center for simulation of supersonic and hypersonic flows. The DPLR code is an MPI-based, parallel, three-dimensional Navier-Stokes solver with generalized models for thermal and chemical non-equilibrium. This software has been used extensively in atmospheric entry analysis for many projects, such as Space Shuttle, Mars Science Laboratory, and Orion Multi-Purpose Crew

Vehicle/Space Launch System. The course will outline a step-by-step process for running an aerothermal simulation, and examples on simple two-dimensional and three-dimensional shapes will be demonstrated.

Keynote: Ocean Worlds of our Solar System
7:00pm
Pinnacle Ballroom
Speaker: Michelle Thaller (NASA GSFC)

When it comes to worlds with liquid water in our solar system, Earth is currently in fourth place for the total amount. Some of these oceans have just been discovered, while others have tantalized us for decades. What is left of Mars' once-vast seas? What lies under the icy crusts of Europa, Enceladus, and Ganymede? Where else might we find water (and the possibility of life) in places we never thought to look? Looking farther out into space, we are also searching for the ultimate source of this water, as well as the building blocks of life.

Session Descriptions: Thursday, August 6

Thermal/ECLS Steering Committee Team Meeting – Invite Only
8:00am – 12:00pm
Council Room

Passive Thermal Presentation Session VI
8:00am – 10:00am
Discovery Room
Session Chairs: Laurie Carrillo (NASA JSC), Ruwan Somawardhana (JPL)

8:00	TFAWS15-PT-21	"Thermal Design and Model Correlation for the Raven Payload" *Presenter: Sean Davis (SGT Inc)*
8:30	TFAWS15-PT-22	Withdrawn
9:00	TFAWS15-PT-23	"Dynamic Radiative Surface Properties with Origami-Inspired Topography" *Presenter: Rydge Mulford (Brigham Young University)*
9:30	TFAWS15-PT-24	"An Introduction to Atomic Layer Deposition" *Presenter: Vivek Dwivedi (NASA GSFC)*

Common Modeling Mistakes
8:00am – 10:00am
Inspiration Room
Instructor: Ruth Amundsen (NASA LaRC)

Course will cover the some of the common mistakes made in thermal modeling, and how to avoid them. Thermal Desktop will be used as a platform to demonstrate many of the common errors by both new analysts as well as experienced engineers in building a thermal model. Other non-software-associated errors will also be covered. Topics covered will include common errors in assumptions, materials, configurations, radiation, orbital analysis, and common faults in problem setup, analysis case runs and record-keeping. The course should help you as an engineer to watch for these common errors in the future, and help you avoid them.

COVeR: Capture Output and Verify Results Training
8:00am – 10:00am
Ambassador Room
Instructor: Hume Peabody (TMS)

COVeR is a stand-alone post-processing environment that allows users to quickly find and display nodes or groups of interest, leveraging the data structures in TARP. It includes the ability to display raw output from thermal models (such as Temperature, Heat Load, etc.) as well as derived data form the same output files (such as Sink Temperatures and Heat Flows). This data is displayed as a transient plot along with the corresponding tabular data. Furthermore, COVeR includes the capability to display heat flows between groups in a block diagram form, which provides a much more intuitive display of the thermal design. Numerous options exist to control the display output, such as heat imbalances, conductance values, color bars, etc. Layouts may be saved and retrieved for use with updated output files or even other cases. These images can be pasted into other programs to help the thermal engineer convey the overall heat flow of the entire model or subsystem of interest.

Generalized Fluid System Simulation Program (GFSSP)
8:00am – 12:00pm
Leadership Room
Instructor: Andre LeClair (NASA MSFC)

GFSSP is a general-purpose computer program for analyzing steady-state and time-dependent flow rates, pressures, temperatures, and concentrations in a complex flow network. The program is capable of modeling phase change, compressibility, mixture thermodynamics, conjugate heat transfer, and fluid transient (waterhammer). GFSSP was developed at MSFC for flow analysis of rocket engine turbopumps and propulsion systems. This class will show how to the user can quickly develop a system-level thermo-fluid model, discuss the capabilities of the software, and present model examples. Students will build two models as a group activity, and have the opportunity to work one or more hands-on tutorials.

NASA Goddard Space Flight Center Tour
9:00am – 12:00pm
Hotel Lobby
Meet in the hotel lobby to take a bus to the NASA Goddard Space Flight Center for a half-day tour. The tour will include the Goddard Integration and Test facilities, including a look at James Webb Space Telescope flight hardware. To go on this tour, you must have registered ahead of time.

Heat Pipe Presentation Session II
10:00am – 12:00pm
Discovery Room
Session Chairs: Jentung Ku (NASA GSFC) and Franklin Robinson (NASA GSFC)

10:00	TFAWS15-HP-05	"Thermal Vacuum Testing of a Helium Loop Heat Pipe for Large Area Cryocooling" *Presenter: Jentung Ku (NASA GSFC)*

10:30 TFAWS15-HP-06 "Stability Theory for Loop Heat Pipe Design, Analysis and Operation"
Presenter: Triem Hoang (TTH Research)

11:00 TFAWS15-HP-07 "Verification of Loop Heat Pipe Stability Theory: Part I Low-Frequency/High-Amplitude Oscillations"
Presenter: Triem Hoang (TTH Research)

11:30 TFAWS15-HP-08 "Verification of Loop Heat Pipe Stability Theory: Part II High-Frequency/Low-Amplitude Oscillations"
Presenter: Triem Hoang (TTH Research)

Science Goals to Requirements Development
10:00am – 12:00pm
Inspiration Room
Instructor: Dennis Reuter (NASA GSFC)

This short course will present the science goals for a variety of types of imaging and spectral measurements, the thermal requirements that these goals impose on the instruments designed to obtain the measurements, and some of the types of trades that can be made among instrument subsystems to ensure the required performance is maintained. Examples of thermal system evolution from initial concept to final implementation will be given for several actual systems

Lunch: Overview of the NESC and Support to Thermal and Aerosciences
12:00pm – 1:00pm
Pinnacle Ballroom
Speaker: Steven Rickman (NASA JSC)

A brief history of the NASA Engineering and Safety Center (NESC) and an overview of the work performed by this organization is presented along with some examples where the Thermal and Aerosciences disciplines have been used to solve key technical challenges.

Heat Pipe Presentation Session III
1:00pm – 2:30pm
Council Room
Session Chairs: Jentung Ku (NASA GSFC) and Franklin Robinson (NASA GSFC)

1:00 TFAWS15-HP-09 "Application-Specific Heat Pipe Design and Performance Considerations"
Presenter: Jesse Maxwell (Naval Research Lab)

1:30 TFAWS15-HP-10 "Development of 100W-class Loop Heat Pipes for Space Use and On-orbit Experiment Test Plan"
Presenter: Atsushi Okamoto (JAXA)

2:00 TFAWS15-HP-11 "Investigation of Flexibility and Freeze – Thaw Tolerance of Copper – Water Heat Pipes for Space Applications"
Presenter: Sergey Semenov (THERMACORE)

Contamination for Thermal Engineers
1:00pm – 3:00pm
Discovery Room
Instructor: Rachel Rivera (NASA GSFC)

This course will cover the basics of Contamination Control, including contamination control related failures, the effects of contamination on Flight Hardware, what contamination requirements translate to, design methodology, and implementing contamination control into Integration, Testing and Launch.

New and Advanced Features in Thermal Desktop, Demo
1:00pm – 3:00pm
Inspiration Room
Instructor: Douglas Bell (Cullimore and Ring)

This session will provide an overview of new and advanced features within the Thermal Desktop suite and provide demonstration on the use of some of those features. This session is recommended to anyone who wishes to see more advanced capabilities of the Thermal Desktop suite than can be addressed in the introductory session. Since the session is not hands-on, prior experience with Thermal Desktop is not required. Thermal Desktop is a design environment for generating thermal models with additional modules for performing radiation and heating environment calculations (RadCAD) and generating fluid flow circuits (FloCAD). Thermal Desktop is a graphical user interface for SINDA/FLUINT.

TFAWS Steering Team Meeting – Invite Only
1:00pm – 5:00pm
Ambassador Room

CAD Transfer using TSS
1:00pm – 5:00pm
Leadership Room
Instructor: Joe Lepore, Joe Clay (SpaceDesign)

The Transfer application is used to view CAD models and transfer them into TSS geometry format. Transfer has a 'CAD viewer' built-in, allowing you to view any CAD model saved in IGES, STEP, or OBJ format. This viewer shows a meshed representation of the model which can then be transferred to TSS Geometry format in a single step. Using advanced 2-D and 3-D Boolean capabilities (computational geometry), complex CAD entities are converted into thermal surfaces using fewer surfaces for radiation analysis. Transfer methods available include direct conversion to files compatible with TSS v14.01, v13.01 or v12.01, plus a 2-D mesh approximation using surfaces or boundary representation. This class will present a detailed walk-through of the Transfer process, including discussion of B-splines, sequence numbers, composite closed loops, and troubleshooting.

NASA Goddard Space Flight Center Tour
1:30pm – 4:30pm
Hotel Lobby
Meet in the hotel lobby to take a bus to the NASA Goddard Space Flight Center for a half-day tour. The tour will include the Goddard Integration and Test facilities, including a look at James Webb Space Telescope flight hardware. To go on this tour, you must have registered ahead of time.

Interdisciplinary Presentation Session
2:30pm – 5:00pm
Council Room
Session Chairs: Robin Beck (NASA Ames), Xiaoyen Wang (NASA GRC)

2:30	TFAWS15-IN-01	"Update on Advection-Diffusion Purge Flow Model" *Presenter: Lubos Brieda (Particle In Cell Consulting, LLC)*
3:00	TFAWS15-IN-02	"Preliminary Design of Cryogenic Hydrogen Radiation Shield for Human Space Flight" *Presenter: Xiaoyi Li (NASA GSFC)*
3:30	TFAWS15-IN-03	"Temperature Measurement in the Challenging Environment of the ISS UPA Distillation Assembly Using Wireless RFID Sensors" *Presenter: Christopher Evans (NASA MSFC)*
4:00	TFAWS15-IN-04	"State of the Branch: Cryogenics and Fluids at NASA Goddard Space Flight Center" *Presenter: Eric Silk (NASA GSFC)*
4:30	TFAWS15-IN-05	"NASA Applications of Molecular Adsorber Coatings" *Presenter: Nithin Abraham (NASA GSFC)*

Coatings for Thermal Engineers
3:00pm – 5:00pm
Discovery Room
Instructor: Jack Triolo (SGT Inc)

This course will present an overview of a variety of thermal coatings-related topics, including: coating types and availability, thermal properties measurements, environmental testing (lab and in-flight), environmental impacts, contamination impacts, contamination liabilities, determination of BOL/EOL values, and what does specularity mean to the thermal engineer. In addition, coating selection criteria, for a variety of thermal applications, to meet both thermal and contamination requirements, will be discussed.

Effective Schedule and Cost Management as a Product Development Lead
3:00pm – 5:00pm
Inspiration Room
Instructor: Cynthia Simmons (NASA GSFC)

This course provides best practices, helpful tools and lessons learned for staying on plan and day-to-day management of Subsystem flight development after getting Project approval for your Subsystem schedule and budget baseline.

Session Descriptions: Friday, August 7

Advanced TSS
8:00am – 12:00pm
Ambassador Room
Instructor: Joe Lepore, Joe Clay (SpaceDesign)

This hands-on class will demonstrate more TSS features and modeling techniques. Topics include: Radiation analysis of CAD surfaces using STEP and IGES Translators, SindaWin application and using LDDATA to automatically record local minimum and maximum temperatures, Geometry model validation, building models with Symbols, distributed processing, managing Boolean surfaces and chains, adjusting conductor values, using the Mesh and FEM applications, and SATSTRAN. Topics of specific interest to users and v15 enhancements will be discussed. Example topics include the rich feature set in TSS such as programming in the command language, utilizing TSS as a prototyping tool, eliminating costly 3rd party applications to move data from a CAD package to a thermal software system, and utilizing TSS as a simple CAD package.

CubeSat Thermal Design
9:00am – 11:00am
Discovery Room
Instructor: Juan Rodriguez (NASA GSFC), Deepak Patel (NASA GSFC), and Eric Gorman (NASA GSFC)

What does it take to thermally design low cost, low mass cubesats? What are the differences in the approach when you compare with large scale missions? What additional risk is acceptable? What is the approach to hardware? How is the testing campaign run? These are some of the questions that will be addressed in this course, which is designed to equip you to support the development of cubesats at your organization.

Liquid-fuelled rocket system transients: analysis with Flownex
9:00am – 11:00am
Leadership Room
Instructor: Herman van Antwerpen (Flownex)

Flownex thermal-fluid system simulation software will be demonstrated with transient simulations of the RL-10A rocket engine as well as a nuclear rocket engine similar to the NERVA rocket. For a nuclear rocket, the point kinetic neutronic model in Flownex enables investigation of the dynamic interactions between neutronics, turbomachinery, temperatures, flow rates and thrust.